REMARKS

Basis for the additions to amended claim 8 can be found in the specification, pages 7, 21 - 22, in the drawing, in original claim 30, part A, and claim 31. Basis for new claims 34 to 35 can be found in the drawing, in Examples 8 and 9, and in original claims 8, 12 - 14, and 30 -31. It is noted that "gas diffusion cathodes" are equated with "air depolarized cathodes" in the specification on page 3, lines 14 - 15.

I. GENERAL CONSIDERATIONS - THE PRIOR ART

Before commenting specifically upon the enablement, anticipation, and obviousness rejections, it seems advisable to review briefly the intent and purposes of the invention. In essence, the invention is concerned with providing to the art a simplified, continuous, cyclic, alkali metal halate electrochemical process, including an assembly for conducting said process, in which substantially less energy is used than in prior art commercial processes, said process operating without the use of sodium bichromate, sodium hydroxide, or hydrochloric acid feed chemicals, which are

normally required for prior art, commercial electrochemical processes for the production of sodium chlorate. In addition, the inventive process does not produce mixtures of hydrogen and oxygen that are potentially explosive, as is the case with prior art electrochemical processes for producing sodium chlorate and said process produces an alkali metal halate containing product having a chlorate to chloride mole ratio which is suitable for direct feed to a modern pulp mill chlorine dioxide generator without further chemical treatment, such as the removal of bichromate, which is required in prior art processes.

In the prior art, electrochemical processes for the production of sodium chlorate are conducted in an electrochemical cell in which the anode and cathode electrodes are immersed in a sodium chlorate electrolyte, which is defined as an aqueous mixture of sodium chloride and sodium chlorate, each at concentrations close to the saturation point. At the anode of the cell, chlorine is evolved and at the cathode, hydrogen is evolved. Hydroxyl ions are also produced at the cathode. Chlorine produced at the anode combines with hydroxyl ions produced at the cathode to form hypochlorite. As the electrolysis proceeds, the hypochlorite concentration increases to a level where it starts to convert to chlorate.

A steady state concentration of between 2 and 5 grams per liter of sodium bichromate is used during the prior art electrochemical process to produce sodium chlorate to prevent an inefficient side reaction in which hypochlorite is reduced back to chloride on the cathode surface. Since sodium bichromate is a carcinogen and

accordingly, an environmental hazard, it has long been considered desirable to conduct the cell reaction without the addition of sodium bichromate.

In the prior art electrochemical sodium chlorate process, an inefficient loss of chlorine occurs since the chlorine produced at the anode is swept away with the large volume of hydrogen evolved at the cathode during the reaction. The chlorine which is lost must be replaced by the addition of hydrochloric acid in order to maintain the pH at the desired 6.4 - 6.9 range. In addition, since the hydrogen produced in the reaction contains chlorine as a contaminant, the hydrogen must be passed through a scrubber to remove the chlorine contaminant prior to burning the hydrogen for fuel or discharging the hydrogen to the atmosphere. Accordingly, the loss of chlorine from the cell results in the need to replace the lost chlorine with externally supplied hydrochloric acid, which is added to the electrochemical cell for pH control.

In the prior art electrochemical sodium chlorate process, another inefficient side reaction results in the evolution of oxygen from the anode surface. The mixing of oxygen produced at the anode and hydrogen produced at the cathode of the cell can become explosive if the oxygen content exceeds 4 % by volume of the mixture. In the prior art process, the production of oxygen is kept within safe limits by the appropriate selection of an efficient cell anode. In some cases the evolution of oxygen from the anode can be inhibited by the presence of the sodium bichromate in the cell electrolyte.

In the prior art electrochemical sodium chlorate process, the anodes of the cell are usually made from precious metals thermally deposited on a titanium substrate. These anodes have a high current efficiency and are characterized by a very low overvoltage for chlorine evolution. Such anodes operate at close to theoretical values. Accordingly, there is very little room for improvement in anode selection over those used in the prior art since the prior art anodes are quite power efficient.

In the prior art electrochemical sodium chlorate process, the cathodes of the cell are usually made from mild steel or titanium. Mild steel is advantageous as compared to titanium because it is characterized by a lower electrochemical overvoltage and, therefore, its use results in lower electrical power consumption and in lower cost per ton of sodium chlorate product as compared to the use of titanium cathodes. However, mild steel cathodes corrode when the electrical power is shut off, as occurs periodically during cell operation. Titanium, when used as a cell cathode does not corrode when the electrical power is shut off but this cathode has a higher electrochemical overvoltage than mild steel cathodes, thereby resulting in the consumption of more power per ton of chlorate produced when using mild steel cathodes. In addition, titanium forms hydrides during cell operation because of combination with the hydrogen produced at the surface of the cathode which results in slow eroding and spalling of the titanium cathodes. Accordingly, titanium cathodes must be replaced periodically at a substantial cost.

Improved results could be obtained in the prior art sodium chlorate process if precious metal coated cathodes were used rather the mild steel or the titanium

cathodes now used since such cathodes would have substantially lower power consumption in a sodium chlorate cell. However, the use of precious metal coated cathodes in prior art chlorate cells is impractical because the electrodes are exposed to the same electrolyte as the result of the absence of a cell separator. For instance, if a precious metal coated valve metal, such as titanium, is used as the substrate and the combination used as a cathode in a prior art chlorate cell, hydrides are formed during cell operation on the valve metal substrate. After a short time of operation, the hydrides and the precious metal coating fall away from the cathode substrate. If a non-valve metal is used as a substrate for a precious metal coating, corrosion of the substrate metal occurs. A precious metal coating on stainless steel or nickel substrates can be used when exposed to alkaline conditions where these substrates do not corrode such as in a chlor-alkali electrochemical cell. However, both nickel and stainless steel substrates corrode under the prior art chlorate cell conditions when the electrical power is turned off, as results under commercial cell operation, thus contaminating the electrolytes with the corrosion products. In such cases one of the corrosion products will be nickel. Nickel in solution is known as a catalyst for the decomposition of chlorate into chloride and oxygen and therefore the use of such coated products as cathodes in the prior art is contra-indicated. Were such a coated cathode to be used in the prior art cell, the decomposition of hypochlorite into chloride and oxygen would also substantially elevate the oxygen content of the oxygen-hydrogen gas mixture, produced in the cell, to result in explosive concentrations. Mild steel, when substituted for a non-valve metal as a substrate for a precious metal coated cathode, is usually not a suitable substrate for the application of a precious metal coating.

In the prior art chlorate cell, the substitution of hydrogen evolution cathodes, also called oxygen reduction cathodes, has been suggested. Such cathodes have a much lower theoretical half cell potential than the hydrogen evolution reaction and, therefore, have been suggested to substantially lower the power consumption of the prior art chlorate cell. Such cathodes have been utilized in fuel cells, however, such cathodes are usually made from materials which would corrode in a prior art chlorate cell in which the cathode is exposed to the same electrolyte as the anode. In addition, there is no way to feed the required air or oxygen to the cathode in a prior art cell for the production of sodium chlorate.

II. GENERAL CONSIDERATIONS - THE INVENTIVE CHLORATE CELL

Contrastingly, in the inventive electrochemical cell assembly and process of the invention, there is employed a diaphragm or permselective membrane separating the anode and cathode of the electrochemical cell. During operation of the cell the catholyte comprises an aqueous solution of sodium hydroxide. The anolyte comprises a mixture of sodium chloride and sodium chlorate, each at concentrations close to the saturation point. In order to control the pH at the desired 6.4 - 6.9 for the efficient production of sodium chlorate, a pH control loop and gas liquid disengagers in the loop are used to connect the cathode compartment and anode compartment. This allows the removal of sodium hydroxide from the cathode compartment of the cell for addition to the anode compartment of the cell. The cathode comprises a catalytic, metal cathode or a gas-diffusion cathode. Accordingly, by these changes in structure, the following improvements can be achieved:

1. Low overvoltage, precious metal coated cathodes can be used in the inventive electrochemical cell to replace the mild steel or titanium cathodes used in the prior art processes. Accordingly, during operation, the inventive electrochemical cell assembly consumes less energy. The use of the precious metal coated cathode or the gas-diffusion cathode is the direct result of the fact that in the electrochemical cell of the invention, the cathode is not in contact with the corrosive, aqueous, sodium chlorate containing electrolyte. Instead, the catholyte of the inventive chlorate cell is a non-corrosive, aqueous solution of sodium hydroxide. The use of a gas-diffusion, or oxygen reduction, cathode results in a cell voltage of about one-half the cell voltage of a prior art chlorate cell having a titanium cathode.

2. By the use of the inventive assembly including an electrochemical cell, the use of sodium bichromate can be eliminated, since the hypochlorite produced in the cell is not exposed to the cathode, where it can be reduced back to chloride.

3. By the use of the inventive assembly including an electrochemical cell, there are essentially no losses of chlorine. The large amount of hydrogen produced in the cell is confined to the cathode compartment by the membrane or diaphragm and is not in direct contact with the chlorine, produced at the anode, where it can sweep away the chlorine, as in the prior art chlorate cell.

4. By the use of the inventive assembly including an electrochemical cell, the addition of externally supplied hydrochloric acid to the electrolyte is

eliminated, since the recycling of the sodium ion to the anode compartment compensates for the small losses of chlorine from the anode compartment resulting in the reduction of pH in the anolyte compartment. The sodium ions which are transported to the catholyte compartment through the diaphragm or permselective membrane combine with the free hydroxyl groups from the cathode reaction to form sodium hydroxide. The sodium hydroxide is subsequently fed as an aqueous solution to the anode compartment by way of a pH control loop in order to maintain the pH in the anolyte at the desired 6.4 - 6.9. In the electrochemical cell assembly and process of the invention, the addition of externally supplied sodium hydroxide is eliminated. The small amount of chlorine which can escape from the anode compartment is scrubbed out in a packed bed scrubber in the control loop through which the sodium hydroxide is returned to the anolyte compartment. The mass balance of sodium and chloride is thus maintained in the inventive electrochemical chlorate cell process.

5. By the use of the inventive electrochemical assembly including an electrochemical cell, no hazardous mixtures of oxygen and hydrogen gases are produced since the permselective membrane or diaphragm separator prevents the anodic oxygen gases from mixing with the hydrogen produced at the cathode.

With this amendment, the Applicants' claims 8 - 17 have been directed to an assembly including an electrochemical cell to produce an alkali metal halate. The Examiner in the Official Action has utilized prior art references disclosing electrochemical cells; all of which references fail to disclose the production of alkali

metal halates, as basis for the anticipation and obviousness rejections of the Applicants' claims 8 - 17. New claims 34 - 35, with this amendment, are directed to an assembly including an electrochemical cell for producing an alkali metal halate. The prior art does not teach the replacement of the mild steel or titanium cathodes used in prior art chlorate electrochemical cells with the more efficient catalytic metal or gas-diffusion cathodes use in the claimed inventive assembly including an electrochemical cell. Accordingly, these references, taken alone or in combination would not anticipate or render obvious the Applicants' amended claims 8 - 17 and new claims 34 - 35.

Clearly, the Applicants' original, independent claim 8 is directed to a cell (for the production of an alkali metal halate), rather than directed to a permselective membrane, nevertheless, the Examiner has rejected claims 8 - 17 as non-enabling. There is no requirement in section 112 of 35 USC that a proprietary component of an apparatus be described in how to make terms when such component is known in the art and is available to those skilled in the art. The Applicants' pending amended claims 8 - 17 and newly added claims 34 - 35 relate to improvements in an electrochemical alkali metal halate cell. No reference cited by the Examiner relates to such cells or suggests the claimed assembly. Accordingly, the Applicants' amended claims 8 - 17 and new claims 34 - 35 are novel and unobvious and deserve recognition as such by the Examiner.

III. SPECIFIC CONSIDERATIONS

A. NON-ENABLEMENT

In the following discussion and in all the subsequent discussions herein, references to the Manual of Patent Examining Procedure (MPEP) are to sections of the Eighth Edition, Revision 3, August 2005.

Claims 8 - 17 stand rejected under 35 USC 112, paragraph 1, as failing to comply with the enablement requirement. The Examiner has indicated in the Official Action that the Applicants have not described how to make a "low" alkali metal ion transport efficiency cell membrane in the specification, particularly, how to make a membrane having an alkali metal transport efficiency of less than 60 %, much less than 20 %. The Examiner seeks to support his position on non-enablement by citing Hobbs et al. relating to the electrochemical recovery of sodium hydroxide from alkaline waste solutions. On page 7 thereof, a statement is made that the sodium ion migration efficiency of a Nafion type 350 membrane can be reduced by selection of a different current density for the operation of the electrochemical cell. The reference is vague as to whether increasing or decreasing the current density results in changes in the sodium ion migration efficiency from 90 % to 67 %.

It is respectfully submitted that the Applicants' specification is sufficiently enabling to meet the requirements of 35 USC 112, first paragraph for the following reasons: At the outset, it is emphasized that the Applicants' pending claims 8 - 17, with this amendment, are directed to an assembly including an electrolytic cell for

the production of an alkali metal halate, <u>not</u> to a low alkali metal ion transport efficiency permselective membrane.

In accordance with the test for enablement set forth in MPEP 2164.01, a particular claim is supported (enabled) by a disclosure in a patent application if one reasonably skilled in the art could make or use the invention from reference to the disclosure coupled with information known in the art without undue experimentation. A patent application need not teach, and preferably omits, what is well known in the art.

In the Applicants' specification on page 29, Example 10 is provided showing the performance of an electrochemical cell for the production of an alkali metal chlorate in which a proprietary product, Nafion 551, is used as a permselective membrane. The sodium ion transport efficiency of this membrane was measured and found to be 65 %. It is noted that the membrane sold under the trademark Nafion 551 is available to those skilled in this art and thus satisfies a key issue for enablement, as set forth in MPEP 2164.01 (b). Since Nafion 551 is a commercial, proprietary product, the Applicants' need not disclose a method for its preparation. By the Examiners' reasoning, one skilled in the art could not obtain a claim to an apparatus or composition employing a proprietary component whose method of making has not been publicly disclosed.

The Examiner states that the scope of enablement in the specification is insufficient for the membrane. In accordance with MPEP 2164.08, the scope of

enablement must only bear a reasonable correlation to the scope of the claims, as set forth in *In re Goffe, 542 F2d 564, 567, 191 USPQ 429, 431 (CCPA 1976)* in which the Court stated:

> "[T]o provide effective incentives, the claims must adequately protect inventors. To demand that the first to disclose shall limit his claims to what he has found will work or to materials which meet the guidelines specified for "preferred" materials in a process such as the one herein involved would not serve the constitutional purpose of promoting progress in the useful arts."

It is acknowledged, as indicated in MPEP 2164.03, that the scope of the required enablement may vary inversely with the degree of predictability involved, but even in unpredictable arts, such as in the field of chemistry, a disclosure of every operable species is not required. Here, the Applicants are the first to disclose an assembly, including an electrochemical cell which contains a cell separator, for the production of an alkali metal halate. As such, the Applicants have disclosed a "Pioneer Invention". The Applicants' claims must adequately protect the invention against those who come after and make improvements thereon. It is only reasonable that the scope of the Applicants' claimed invention not be limited to the low alkali metal ion transport efficiency permselective polymer membrane disclosed in the Applicants' Example 10 since to do so would leave the field open to others to seek protection for the use of similar membranes having even lower alkali metal ion transport efficiency than the membrane disclosed in the Applicants' Example 10.

With respect to the Examiner's citation of Hobbs et al. showing the use of a Nafion 350 membrane in an electrochemical cell operated for the recovery of sodium hydroxide from alkaline waste solutions, it is respectfully submitted that it is considered irrelevant for the Examiner to suggest that the Applicants' specification is non-enabling for the pending claims on the basis that a variation in current density during the operation of the cell of Hobbs et al. results in a change in the sodium ion migration efficiency through the same cell membrane cell separator. It is noted that the Applicants' pending claims 8 - 17, with this amendment, are directed to an assembly including an electrochemical cell, <u>not to a process</u> for conducting an electrochemical cell reaction. Whether or not, process conditions can change the sodium ion migration efficiency for a Nafion membrane is, accordingly, considered irrelevant to the enablement of the Applicants' pending claims to an assembly including an electrochemical cell. Reconsideration and withdrawal of the rejection of the Applicants' pending claims as non-enabled in the specification are respectfully requested.

B. ANTICIPATION

Claims 8 - 12 and 17 stand rejected over Kelham with evidence from de Nora '452. Claim 13 stands rejected under 35 U.S.C. 102(b) over Kelham with evidence from de Nora et al. '979.

As noted in MPEP 2131.01, a multiple reference rejection under 35 U.S.C. 102 has been held to be proper when the added reference is cited to explain the meaning

of a term used in the primary reference. Here, the Examiner has used de Nora to explain the meaning in Kelham of a Nafion membrane and de Nora et al. to exlain the meaning of the electrocatalyst coating in Kelham, which is disclosed in de Nora et al. as a coating of a platinum group metal oxide.

With this amendment, the Applicants claim an assembly including an electrolytic cell and gas and liquid disengagers for anolyte and catholyte streams which pass between the catholyte and anolyte compartments of the elelctrolytic cell. It is not seen that the Applicants' currently amended claims 8 - 17 would be anticipated by the cited reference to Kelham and the de Nora and de Nora et al. references. New claims 34 - 35 claim this assembly but instead of a low alkali metal ion transport permselective polymer membrane recite merely a permselective polymer membrane.

Kelham discloses chlor-alkali electrochemical cells, as noted in column 1, lines 40 - 44. The de Nora and de Nora et al. references disclose chlor-alkali cells, as noted in the abstract.

Should the Examiner consider that the disclosure in Kelham of a Nafion membrane is a generic disclosure such that the genus of membranes sold under the trademark Nafion would anticipate the Applicants' species of Nafion membrane, it is respectfully submitted that the disclosure of Nafion membranes in Kelham would not suggest, for the following reasons, the Applicants' use of a low alkali metal ion

transport efficiency permselective polymer membrane in the Applicants' amended claims 8 - 17. New claims 34 - 35 would not be anticipated on other grounds.

MPEP 2131.02 is instructive as to whether a generic chemical formula or a generic expression would be sufficient to anticipate a species falling within the genus. Generally, a chemical formula will anticipate a species covered by the formula only when the species can be "at once envisioned" from the formula. Where the generic expression embraces a large number of species, the generic expression cannot be said to anticipate the species. Here, the generic expression "Nafion membrane" encompasses a large number of membranes having properties including the permeability of various ions, as well as rate of permeability of said ions. Accordingly, the disclosure of a Nafion membrane in the references cited by the Examiner cannot be said to anticipate the Applicants' use of the low alkali metal transport efficiency permselective polymer membrane. Reconsideration of the Applicants' amended claims 8 - 17 and allowance of these claims together with consideration and allowance of new claims 34 - 35 are respectfully requested.

Claims 8 - 12, 14, and 17 stand rejected under 35 USC 102 (b) as anticipated by Cohn et al. with evidence from de Nora '452. Cohn et al. disclose chlor-alkali cells, as noted in the abstract and column 1, lines 9 - 11. With this amendment, Applicants' claims 8 - 17 have been amended in order to more clearly describe the invention. The discussion above with respect to the anticipation of a species by a genus is incorporated herein.

Regarding the Examiner's assumption as stated in the second paragraph on page 5 of the Official Action, pertaining to claims 8 - 11 and 17 as well as in the prior rejection over Kelham, as stated in the third paragraph, item 7 on page 4 of the Official Action, it is respectfully submitted that one of ordinary skill in the art would not assume that every copolymer of tetrafluoroethylene and a perfluorovinyl monomer would be suitable, without specific processing, for achieving the low alkali metal ion transport efficiency polymer membrane recited in the Applicants' amended claims 8 - 17 in view of the wide diversity of properties in membranes sold under the Nafion trademark and the fact that the Applicants' specification on page 14, first paragraph, would be considered by one skilled in this art to be merely a generic disclosure.

Accordingly, it is respectfully submitted that the Applicants' amended claims 8 - 17 are not anticipated, especially since, with this amendment, independent claim 8 recites additional structure for the claimed assembly over that recited in original claim 8. In addition, it is respectfully submitted that newly added claims 34 - 35 are not anticipated by Cohn et al. with evidence from de Nora '452 on the basis that these claims recite sufficient structure to distinguish these claims over the teachings of Cohn et al. and de Nora. Reconsideration and allowance of amended claims 8 -17 are respectfully requested and consideration and allowance of new claims 34 - 35 are respectfully requested.

C. OBVIOUSNESS

Claim 13 stands rejected under 35 USC 103 (a) as obvious over Kelham in view of de Nora et al. '979, Claim 15 stands rejected under 35 USC 103 (a) as obvious over Kelham in view of Brown et al. ('269), and Claim 16 stands rejected under 35 USC 103 (a) as obvious over Kelham in view of Kuo et al. ('531). It is noted that all the references cited except Brown et al. and Kuo et al. disclose chlor-alkali cells. Brown et al. disclose water electrolysis cells and Kuo et al. merely disclose cathodes for electrochemical cells.

In accordance with MPEP 2141, patent examiners are responsible for applying in each and every case the standard of patentability for obviousness enunciated by the Supreme court in *Graham v. John Deere*, 383 US 1, 148 USPQ 459 (1966). Accordingly, consideration and a determination of obviousness requires that the Examiner make the four factual inquiries enunciated in Graham as follows:

(A) Determining the scope and content of the prior art;
(B) Ascertaining the differences between the prior art and the claims in issue;
(C) Resolving the level of ordinary skill in the pertinent art; and
(D) Evaluating evidence of secondary considerations.

In addition, certain generally accepted patent law considerations must be applied when the Examiner makes an obviousness rejection:

(A) The claimed invention must be considered as a whole:
(B) The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination;
(C) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and
(D) Reasonable expectation of success is the standard with which obviousness is determined.

It is respectfully submitted that the Examiner has failed to follow the guidelines of Graham in making the above obviousness rejections and in addition has failed to apply all the above generally accepted patent law considerations. In particular, it appears that the Examiner has used impermissible hindsight vision and failed to determine the scope and content of the prior art, especially with respect to electrochemical cells for the preparation of an alkali metal halate. The Examiner has cited no halate cell references but merely references which would be considered by one skilled in the art to pertain to chlor-alkali electrochemical cells and processes. Accordingly, the Examiner has failed to consider the Applicants' invention as a whole, that is, an invention relating to the electrochemical preparation of an alkali metal halate. The Examiner has also failed to provide reasons why one skilled in the art would expect to have a reasonable expectation of success in applying the teachings of those cited chlor-alkali electrochemical cell references to the problems specifically associated with electrochemical cells for the preparation of alkali metal halates.

The Applicants' amended claims 8 - 17 have been directed to an assembly including an electrochemical cell employing a low alkali metal ion transport efficiency

permselective polymer membrane and new claims 34 - 35 have been added to an assembly including an electrochemical cell and a permselective polymer membrane. It is respectfully submitted that no reference cited by the Examiner to reject the Applicants' claims (specifically claims 13, 15, and 16) would suggest the Applicants' invention as a whole, much less suggest the Applicants' claimed assembly recited in amended claims 8 - 17 and new claims 34 - 35. Nor would a person skilled in the art have a reasonable expectation of success in applying the teachings of the chlor-alkali cell references cited by the Examiner to the problems specific to an electrochemical cell for the preparation of an alkali metal chlorate, as noted above. Reconsideration and allowance of amended claims 8 - 17 are respectfully requested and consideration and allowance of new claims 34 - 35 are requested.

For all the reasons given above it is respectfully requested that the Examiner reconsider the rejection of the Applicants' amended claims 8 - 17 and consider the patentability of the Applicants' new claims 34 - 35 and allow all the Applicants' claims 8 - 17 and 34 - 35.

Respectfully submitted,

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I hereby certify that this paper (along with any referred to as being attached or enclosed) is being deposited with the U.S. Postal Service with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on January 30, 2006

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